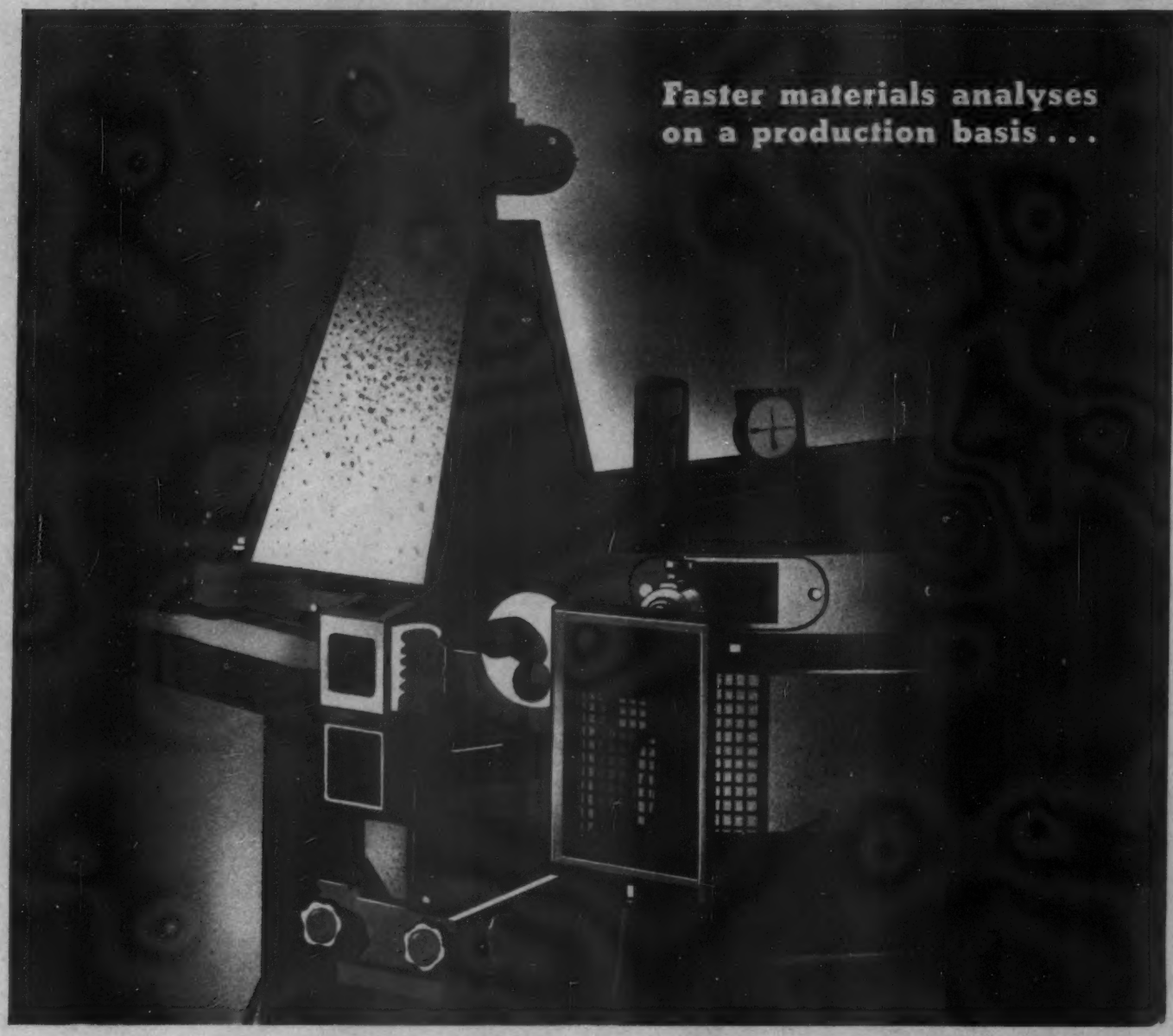
TECH ENGINEERING NEWS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

MARCH • 1943

ROENTGEN-RAY GENERATOR

SEE PAGE 77



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Spectograph equipment is now being used by Fairchild for the analysis of materials. Such analyses are necessary to insure that the materials meet the exacting specifications required for highly stressed engine parts. No deviation can be tolerated and constant laboratory control must be maintained. With the spectographic equipment three men can do the amount of work that formerly required thirty.

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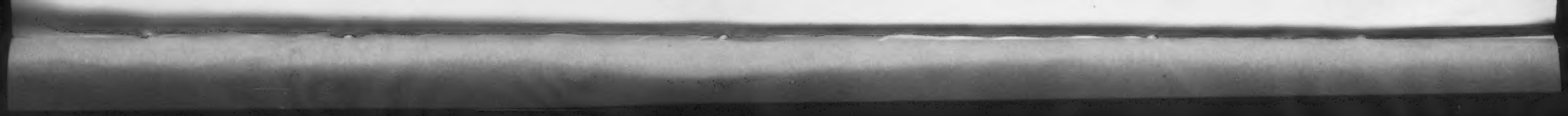

The private war of 王兆振

DR. CHAO-CHEN WANG carries a slide rule instead of a rifle. Logarithms are his bullets. Differential equations, his high explosives.

Yet he's waging just as deadly a war, against the hated Japs, as any of his brave compatriots in far off China.

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Since joining Westinghouse last summer, this young Chinese scientist has made several important contributions in the field of electronics design.

One of them—*a new method for measuring the output of ultra high frequency radio tubes*—may prove as valuable to the United Nations as a million machine-gun bullets fired at the enemy!

Dr. Wang is an expert in the mathematics of ultra high frequency communications. He does his "Jap fighting" in one of the Westinghouse Electronics Laboratories.

Here he employs his special genius in calculating — in advance — the performance and characteristics of electronic tubes *before* they actually take form.

★ ★ ★

DR. WANG, and other young engineers who enter our employ every year, are constantly contributing to the "know how" of the Westinghouse organization.

Westinghouse believes in helping young engineers grow and advance as rapidly as possible—for upon these scientists of tomorrow our whole future depends.

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DR. CHAO-CHEN WANG studied electrical engineering at Chiaotung University in Shanghai. He was sent to Harvard University by the Chinese Government where he specialized in ultra high frequency communications. Before joining Westinghouse, he received his M. S., in 1938, and his Ph. D., in 1940.

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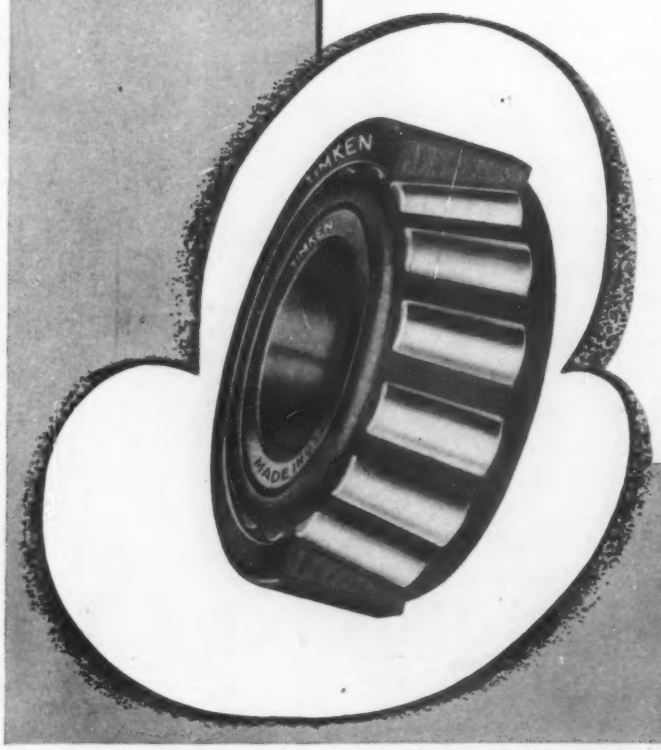

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THE TECH ENGINEERING NEWS

MARCH · 1943

COVER

M. I. T.'s new four million volt, direct current, electrostatic, Roentgen-ray generator seen from above. The pressure tank has been removed, and the light metal shells that fit concentrically over the terminal stand on the ground beside the column.

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MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

Published monthly throughout the school year, at Walker Memorial, Cambridge A, Massachusetts, by the undergraduates of the Massachusetts Institute of Technology. Entered as second class matter, at the Post Office, June 1, 1920, at Boston, Mass., under the Act of March 3, 1879. Copyright 1943 by The Tech Engineering News. Subscription per year $1.50. Foreign $1.50. One copy 25 cents.

PRESCRIPTION IN HIGH VOLTAGE

NEW ROENTGEN-RAY GENERATOR WILL DO MUCH TO AID THERAPEUTIC TREATMENT OF CANCER

By ROGER DAVIS SMITH '45

THE layman has become accustomed to hearing of the frequent contributions of chemistry and biology to medical science. Sulphonylamide and Vitamin B_1 are on his lips. But with the comparatively recent development of high voltage techniques, physics, the "new physics" which talks in terms of the Einstein theory and speeds of light rather than of Newtonian and Galilean laws, has presented its own succession of medical achievements. This article describes one of these, in which physics takes its crack at cancer.

Last summer the High Voltage Group of the Massachusetts Institute of Technology completed the construction of a new direct-current, electrostatic Roentgen-ray generator. Similar in type to those first developed by Dr. Robert J. Van de Graaff of the M. I. T. faculty, the new generator is capable of operation at steady potentials well above four million volts, at which its accelerated electrons attain a speed ninety-eight per cent of the velocity of light. As high-speed electrons, more commonly called cathode rays, cause the emission of X-radiation from metals which they are permitted to bombard, a generator operating at such enormous potentials as this offers an excellent opportunity for pioneer research in the therapeutic treatment of cancer by X-rays. It marks the first time that a source of X-radiation more penetrating than the gamma rays of radium has been made available. The intensity of this X-radiation, furthermore, is greater than would be obtained from the entire world's supply of radium and exceeds that of any existing commercial machine when the generator is run at its normal rating of .5 milliamperes at three million volts.

X-rays destroy the malignant cells of cancer by their ionization properties. For a given X-radiation there is a specific depth at which this action far exceeds that which is produced at other depths. This is called the point of maximum ionization intensity and permits the treatment of areas well below the surface of an afflicted organ without appreciable skin damage if a source of sufficient intensity and penetration is available. Sources of X-radiation whose physical properties are in this way more adaptable to the treatment of cancer have in the past five years been the object of important research and development at M. I. T.

The new generator is the third of its kind in a series of high-voltage X-ray sources constructed at the Institute. The first of these was installed at the Huntington Memorial Hospital of Boston early in 1937 and was used continuously for medical purposes until the closing of the hospital toward the end of 1941. This air-insulated generator developed one million volts, which was five times greater than potentials then normally available for deep X-ray therapy. The second, operating at 1.25 megavolts, was put in use at the Massachusetts General Hospital in 1939, and has since been treating a score of patients daily. During its first year of operation one hundred and eighty-two complete treatments for thirty-five different types of malignancies were performed by the instrument. In the course of these two previous therapy programs, however, it became evident that at still higher voltages (1) a greater fraction of the incident energy would reach the underlying tissues, (2) skin damage would be less for the same biological effects at a depth, and (3) there would be less back and side scattering of rays. The desire to investigate completely the therapeutic properties of X-radiation at these higher voltages as well as to experiment with the biological effects of high-speed electrons for use directly in superficial therapy led to the development of the new four million volt gas insulated generator.

The new generator, designed by Dr. John G. Trump and Robert W. Cloud, is far more compact than its predecessors. Sealed for insulation in a tank containing a mixture of gases under pressure, it stands thirteen feet high and four and one-half feet in diameter. Figure 1 shows the generator column itself without this tank. The Roentgen-ray tube, fixed vertically inside the column, projects into an underground radiation and treatment room of the special laboratory building.

The voltage source of the new generator consists essentially of a well-rounded high voltage terminal, two feet in diameter, supported from the ground by a column structure of alternate insulating and metallic spacers. The terminal voltage is thus evenly divided down the column by means of resistors so as to produce a uniform gradation of potential from the charged terminal to the ground. Inside the column a single

A side view of the generator column itself, showing the high voltage terminal, the alternate insulating and metallic spacers, and the separate metallic shells which will be placed over the terminal.

Roger Davis Smith has been on the staff of THE TECH ENGINEERING NEWS *a year and a half and recently became its Publications Editor. He comes from Yonkers, N. Y., attended the Buckley and Hotchkiss Schools, and is now a sophomore in the Industrial Relations option of Chemical Engineering. A member of Sigma Alpha Epsilon fraternity and the Army Enlisted Reserve Corps, Smith has been regularly on the Dean's list. His father, an architect, graduated from M. I. T. in 1905.*

insulating belt, twelve inches wide, travels at four thousand feet per minute between the ground and the terminal. These details may be seen in the accompanying diagram, Figure 2. The charge is sprayed upon the lower end of the belt from corona points fed by a low voltage rectifier and is continuously carried up into the terminal. According to the electrostatic principle that a charge introduced into the interior of a hollow conductor will be almost completely transferred to it on contact, regardless of its potential, the charge leaves the belt at this point. The terminal will acquire, in direct proportion to the charge thus stored upon it, a negative potential relative to the ground, which will be used to accelerate the electrons in the Roentgen-ray tube. The generator may actually be operated over a wide range of voltages, each value representing a condition of equilibrium between the charge transferred to the terminal by the belt, the current passing back down the tube, and the control currents characteristic of the voltage. This equilibrium may be adjusted from a few hundred thousand volts to the maximum of over four million by regulating the current sprayed upon the charge-conveyer belt.

The Roentgen-ray tube is located vertically within the generator column. It is six and one-half inches in diameter and one hundred and six inches long, reaching from inside the high voltage terminal to the grounded end of the column, where a metal extension projects it through the bottom of the pressure tank into the radiation room below. The tube is made up of one hundred glass (Glasbak), ring-like insulators between each of which is placed a metallic (steel) electrode. Since these electrodes are individually connected with the column at their respective levels, it follows that they are progressively less negative from the terminal to the ground, and thus, by attraction, can perform the double task of accelerating and focusing the stream of electrons which descend from a tungsten filament in the high voltage terminal. These electrons arrive at the bottom of the tube with full terminal energy in a well-defined focal spot about one centimeter in diameter. Thence they are either permitted (1) to pass directly out through a cathode ray portal or (2), more commonly, to bombard a water-cooled gold target for the emission of X-rays. In the latter case the target is surrounded by a suitable thickness of lead shielding and provided with beam-defining portals and a mercury shutter. X-rays such as those emitted from the target are the type of radiation that has generally been used for cancer therapy in the past. But there is also hope that the cathode rays may soon be used directly for the treatment of superficial cancer conditions.

In the construction of a generator which may be operated at such tremendous potentials, insulation becomes the principal engineering problem. The pressure tank in which the entire assembly is mounted has already been mentioned. When containing a medium whose dielectric strength is superior to that of air, it provides the fundamental insulation of the terminal, the conveyer belt, and the generator column as a whole. A mixture of Freon gas (CCl_2F_2) and air at thirteen atmospheres is at present being used. As a further precaution to insure satisfactory insulation, a method of sectionalizing the generator has been adopted also. In this, light metal shells are placed concentrically over the high voltage terminal, dividing the field about it into three distinct regions which each share a fraction of the total voltage drop involved. The shells are, in reality, equipotential surfaces having the voltage of that point at which they join the generator column farther down. This arrangement divides the generator into three units, one within the other, and each electrically unaware of the existence of the other two. It was also found necessary to replace the porcelain rings originally planned for the Roentgen-ray tube with glass ones, for the former shattered under the extremely high potential differences.

That the final velocity of the electrons at four million volts is about ninety-eight per cent of the speed of light has already been observed. It is important to note that higher velocities cannot be practically obtained on account of the rapid increase beyond this speed in the mass of the electron, which tends to infinity as the velocity of light is approached. Generators of higher voltages, therefore, would have the only advantage of permitting greater intensity in their cathode radiation.

An interesting experiment to perform with Dr. Trump's new generator is to expose for a few seconds an inch-thick Lucite block to the naked stream of electrons passing out of the cathode ray portal. The electrons are traveling with such velocity that they are able to penetrate the transparent insulator about one-half inch, there becoming imbedded and building up an invisible layer of concentrated electric charge. A slight addition of electrons will then suffice to break down the insulator, and the accumulated charge will unload like a miniature thunder cloud. The result is a gossamery radiation of lines permanently etched in the volume of the insulator. Each of these hairlike lines represents a track of the discharge and resembles in its outward path and ramifications the familiar plan of a streak of lightning.

Initial experiments conducted with the generator during the summer and early fall showed that the anticipated advantages of higher voltage in cancer therapy had been achieved. First, the X-rays, although maintaining the same physical properties as the gamma rays of radium, permitted longer treatment distances than hitherto possible because of their high intensity, with the result that the depth-dose was much greater. Second, the point of maximum ionization intensity of the X-rays moved progressively further below the surface of the afflicted organ, giving greater skin tolerance than at lower voltages. Third, the back- and side-scattering of the X-rays was materially reduced. It was also ascertained that the intensity of the X-radiation increases even more rapidly than the fourth power of the voltage. This is an interesting factor, since it indicates that the conversion of the kinetic energy of the accelerating electrons into the radiant energy of the X-rays is being accomplished with higher and higher efficiency in machines of increased voltage. A preliminary report on the clinical possibilities of the instrument's radiation was recently presented to the Chicago meeting of the American Roentgen Ray Society by Dr. Richard Dresser of Boston, who is in charge of the medical operation of the generator.

It should be mentioned in conclusion that none of this important work in high voltage generators and cancer research could have been accomplished without the grants of the Godfrey M. Hyams Trust and the coöperation of many individuals who have not been mentioned.

People will always remember this decade of radioactive iodine and super-voltage X-ray generators as the one that initiated physics into medical science. For now quite unexpectedly physics has assumed a role that cannot be temporary. Such developments as M. I. T.'s new four million volt generator must lead to further research and new techniques beyond their lifetime of useful practice.

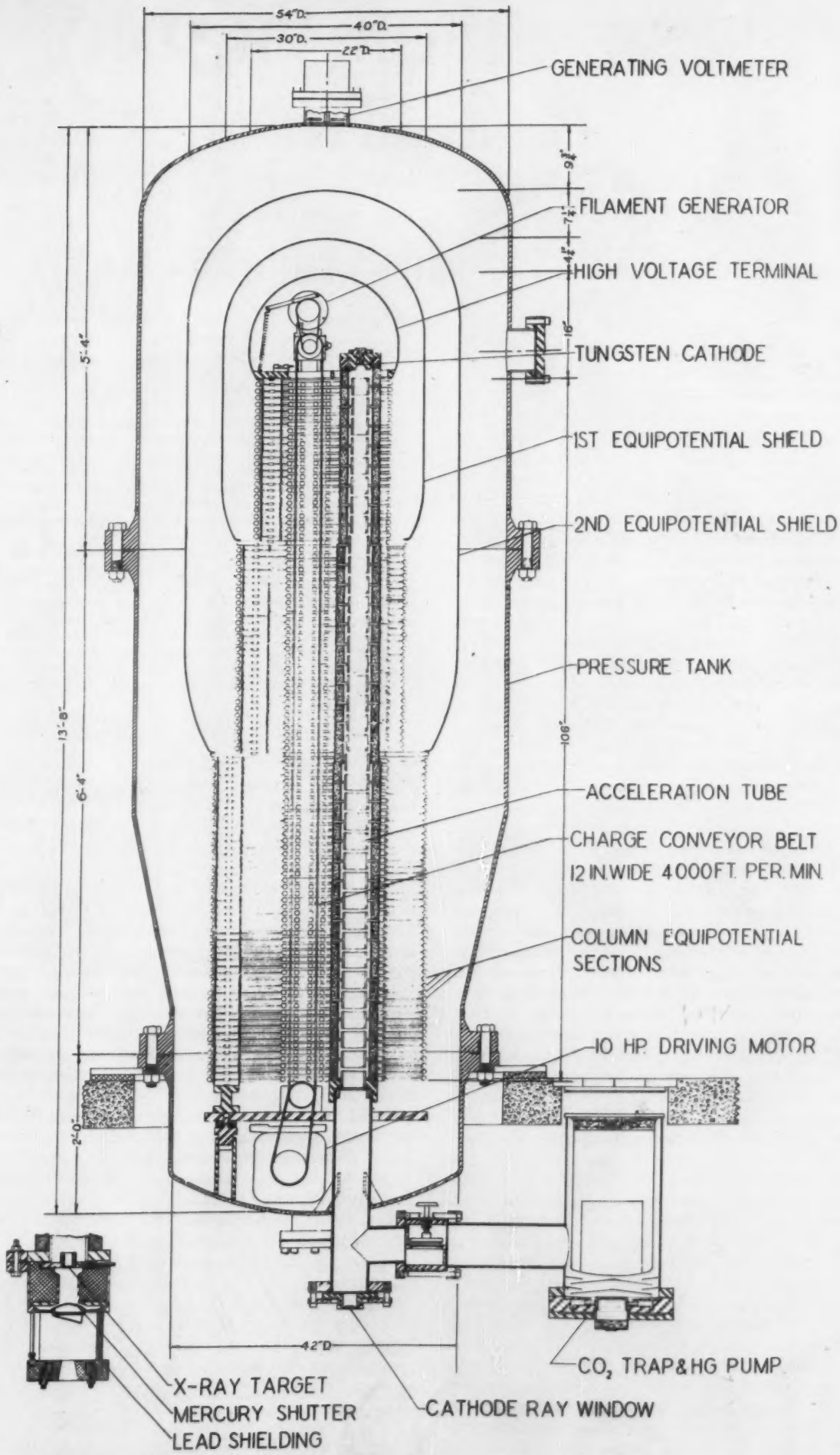


Fig. 2. A diagram of the generator, which is used as a source of both X-rays and cathode rays

SUPPLIERS FOR VICTORY

THE ORDNANCE DEPARTMENT AND THE M. I. T. ORDNANCE R. O. T. C. UNIT

By LIEUTENANT COLONEL ARTHUR D. CASWELL

Lieutenant Colonel Caswell writes from a wide and varied background of experience, originating in a thorough schooling. From Northwestern Preparatory Academy he went to the United States Naval Academy, later transferring to the Army as a second lieutenant in the Field Artillery. In addition, he studied architecture at the University of Minnesota as well as criminal investigation and constitutional law at Treasury Schools. He worked as architectural draftsman from 1928 to 1931 and from 1931 to 1933 became a member of the United States Department of Justice. He is credited with the invention of a target camera and bullet traps. Lieutenant Colonel Caswell's career in the Army began during the first World War and continued upon his transfer from the Naval Academy. His advancement then carried him as captain to the Ordnance Reserve and recently (1940) to active duty with the Reserve Corps, 29 Ordnance Co., Fort Devens. Last fall, while he was on duty as P. M. S. & T. in the Ordnance Department at M. I. T., he attained his present rank of lieutenant colonel, but now has been called away by the service.

THE present war has aroused intense interest in Ordnance activities, and well it should, for most citizens now realize that the task which confronts our nation today is one which can easily be an overwhelming one should we fail to produce the very best possible types of equipment in amounts formerly thought impossible. It is to be regretted that Mr. Average Citizen failed to have this interest during the peaceful days which followed World War I. However, it is just water over the dam now, to bemoan the fact that so many were led to believe another war was simply an impossibility. We can be justly thankful though, that there were enough citizens and soldiers aware of the danger to make sound organizational preparations.

Now that we are off to war again, let us look at one or two things which have prevented a failure. In this respect let us reflect a moment or two on the little group of officers, soldiers and civilians of the Ordnance Department of our Regular Army. When one considers the numbers involved and the task which confronted it, this group should truly receive the credit for accomplishing that which might be termed an impossible mission.

It is true that they were not entirely alone in this matter but they did form the strong foundation of the present wartime organization which has grown to be a mammoth and well-functioning machine. In the peacetime role, scattered groups of one or two Regular Officers quietly worked toward industrial planning and in addition conducted schools for Reserve Officers. They also took steps to procure the necessary commissioned assistance which has since been called to active duty.

There was not a great deal of money to be spent for either of the above tasks and many a Reserve Officer possibly felt, when denied the right to better his military education, that the nation was not entirely fair to him or to the military, when funds were not available for even his meager two weeks annual field training. Some did become discouraged, relinquishing their commissions. Others, for strong patriotic reasons, would not let the lack of funds prevent them from giving their services to the country, even though they were often ridiculed for holding the belief that a day would again come when this nation would be required to resort to the force of arms to protect itself from foreign enemies.

The work accomplished by the thirteen Ordnance District Offices, usually consisting of one Regular Army Officer and one clerk, was so quietly and efficiently done that it is doubtful that even our enemies were fully aware of the magnitude of the task performed. In this mission we find that our industrialists quietly played a wholesome part, and it has been truly amazing how quickly our industries were able to convert their plants to the manufacture of Ordnance materiel and supplies. This was no simple matter. It required hours of study, planning and in some instances even the procurement of vital and complicated machinery in addition to the erection of buildings.

Before proceeding further, it seems desirable to explain briefly the mission of the Ordnance Department, and it may be said that it is charged with the responsibility of the development, design, procurement, storage, supply and maintenance of all Ordnance materiel, including artillery, and ammunition therefor; small arms, and ammunition therefor; bombs, grenades, and pyrotechnics; tanks, self-propelled mounts, motor combat and transport vehicles; and for the training of Ordnance military personnel, including the promulgation of training doctrine, the scheduling of training programs, conducting and supervising training, and the assignment, selection and relief of training personnel. Not a small task at that!

The Ordnance Department, as a part of the Army of the United States, comes under the Services of Supply, or one of the three main groups of our Army. It is divided into numerous divisions and branches for administrative or functional reasons. The controlling division or part is known as the Office of the Chief of Ordnance. It is located at Washington, D. C. The present Chief of Ordnance is Major General Levin H. Campbell, Jr. This office is broken up into the following branches: Executive, Legal, Fiscal, Civilian Personnel, Military Personnel, Control, War Plans and Requirements, Security and Safety, Safety Advisory, and Administration Branch. In addition there is the Ordnance Department Board and the Special Advisory Staff.

The function in general for this office is to perform the executive and administrative duties of the Ordnance Department which are common to all activities.

Military Training Division
Washington, D. C.

This division is responsible for the training of Ordnance military personnel, including the promulgation of training doctrine, scheduling of training programs, conducting and supervising training, selection and relief of training personnel. It is divided into the following branches: Executive, Training Doctrine, Fiscal and Supply, Plans and Requirements, Operations, Inspection, and has the facilities such as schools and training centers.

Technical Division
Washington, D. C.

The Technical Division carries out forward looking programs of research and development of new and improved Ordnance materiel and of improved materials for Ordnance use. It is divided as follows: Ordnance Technical Committee, which is composed of members from each arm or service, civilian experts and members from the Navy and the Marine Corps; Executive Department, Artillery Development, Aircraft Armament Development, Service, Ammunition Development, Tanks and Motor Transport Development, and Small Arms Development Branches, in addition to Proving Grounds.

Industrial Division
Washington, D. C.

This division is charged with the responsibility to procure, produce, inspect and accept all Ordnance materiel and spare parts therefor, and perform the related engineering work. It will provide for the construction of new manufacturing plants and the conversion and expansion of existing plants needed for procurement; and will perform all duties incident to procurement not otherwise specifically assigned, including authorized duties in connection with assigned field establishments, and the maintenance of close coöperation with industry. It has the following branches: Executive, Tank and Motor Transport, Ammunition, Production Service, Small Arms, Artillery and facilities such as Arsenals, Plants and Works, the thirteen Ordnance Procurement Districts, and Proving Grounds.

Tank and Automotive Center
Detroit, Mich.

The responsibility for the design, manufacture and distribution of all Army combat and transport vehicles is with this division. It has the following branches: Executive, Development, Supply and Control.

It constitutes the operating portion of the Office of the Chief of Ordnance concerned with the development, design, manufacture, storage, supply and maintenance of tanks, self-propelled mounts, motor combat and transport vehicles.

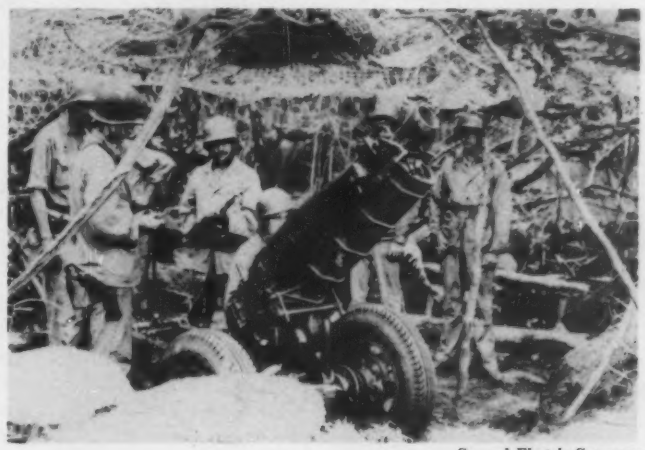
Field Service Division
Washington, D. C.

This division's responsibility is to store and issue Ordnance materiel. It will inspect, repair, alter and maintain Ordnance materiel in the hands of troops and in storage, will formulate spare parts policies, and upon their approval by the Chief of Ordnance, will be responsible for their execution. It will control the supply of spare parts so as to insure ready availability in sufficient quantity where and when needed; will issue requisitions on Industrial Division for parts procurement; will prepare and review technical manuals and review training

(*Continued on page 92*)

General Electric Company

Standard machines are finishing bores and roughing and finishing powder chambers for the 75-mm. pack howitzers



General Electric Company

75-mm. howitzer in use on Guadalcanal Island (Solomon Islands)

U. S. Army Signal Corps

75-mm. howitzer ready for action at Fort Knox, Ky.

HIGH FREQUENCIES MEAN BETTER METALS

INDUCTION HEATING SAVES TIME AND MATERIALS IN THE TEMPERING AND PLATING OF METALS

By ROBERT W. BRONSON '46

WAR production demands quality and quantity of products together with economy of materials; that is why manufacturers are turning toward induction heating for plating and tempering of metals. By this method they may readily heat-treat metal easily and with the greatest amount of perfection. The use of induction heating saves metal, especially in plating. For instance, the amount of vitally scarce tin used in tin plating is being cut about two-thirds by the use of high-frequency induction heating in the place of "direct" heating apparatus for fusing purposes.

The use of induction heating in tin plating for can manufacture offers a good example to study the scientific principles upon which the process is based. The dull, rough, electrolytically tin steel sheets are passed into the induction heater coil where the sheets are heated to the fusion point of tin. As the dull strip moves through the coils, radio waves, 200,000 cycles per second, are passed around the metal, setting up currents near the surface which melt the minute peaks down into the tiny valleys. Shooting into the metal the waves rip electrons — so tiny you could put 10 million million on an inch line — from the atoms of the metal. These electrons, driven by the current, smash into one another, creating heat at each collision. The molten tin forms a bright surface, ready for the can makers. The melting action is stopped as the sheet passes out of the coils and is quenched by water. When the end of the steel strip approaches the coils the operations must be retarded to allow time for another strip to be added to the treated strip by welding. The amount of heat generated by the currents can easily be adjusted to compensate for the loss of speed, whereas in a regular heat-treating furnace this cannot be done.

The fundamental process of induction heating is the same in all types of heat treatment. The desired part is quickly brought to a high temperature, this being done in most cases by introducing a current of high frequency. In the cases where neither differential nor fast heating is required, a low-frequency current may be used. After the part is heated to the temperature required for proper metallurgical results a quenching, usually with water, follows. The time limit and the intensity of heat vary with the type of treatment. If an external or internal surface is to be treated, the current is allowed to last long enough in order that just a few thousandths of an inch become heated. This piece is then quickly quenched, the resulting metallurgical changes leaving a hard surface without disturbing the toughness, ductility, machineability, and dimensions of the main body.

Robert W. Bronson is a freshman planning to study Electrical Engineering at M. I. T. He was born in Erie, Pa. and has lived there all his life. He graduated with honor from Strong Vincent High School in Erie before coming to the Institute last September. Bob is a member of Theta Chi fraternity. This is his first article in THE TECH ENGINEERING NEWS.

In the use of induction heating the time limit is small, usually only a few seconds being needed. Time limits as low as 0.2–0.3 seconds have been proven sufficient to cause the proper metallurgical changes in some steels. A few years ago the metallurgist's belief was that to bring about proper carbide solution, the metal must be held at a supercritical temperature for long periods of time. Recent research developments have proven this belief to be false, that small time periods are sufficient if properly controlled. For this reason, the fact that metal can be brought to a high temperature in a few seconds is an important advantage of induction heating. Controlled temperatures up to 3600 degrees Centigrade have been attained.

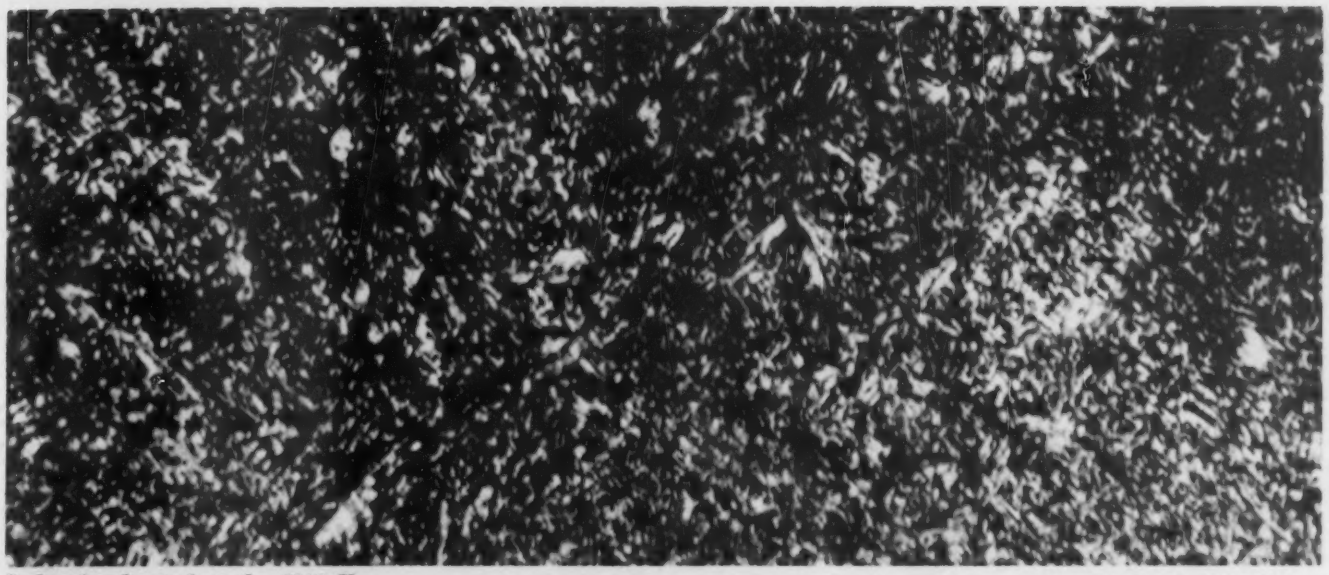
Induction heating causes a homogenous structure of nodular (spherical) crystals to form whereas furnace heating forms a less homogenous structure composed of articular (needle-like) crystals. Because of the structure caused by induction heating, the metal has a stronger texture. The nodular crystals give the material more life and protection against cracking and chipping.

Since most induction heating apparatus is a combination heating and quenching unit, the quenching follows the heating almost instantaneously. The oxidation of the metal does not have a chance to take place to any great extent, consequently there is only a minute scale formed on the treated surface. If necessary, all oxidation can be entirely eliminated.

As in the case of minimizing oxidation, heating to a high temperature, limiting the heat to a shallow layer of metal, and employing a small time factor and immediate quenching, causes the amount of distortion to remain small. In most cases the distortion is negligible. This eliminates all annealing or normalizing treatment. All of these facts facilitate rapid, accurate inspection.

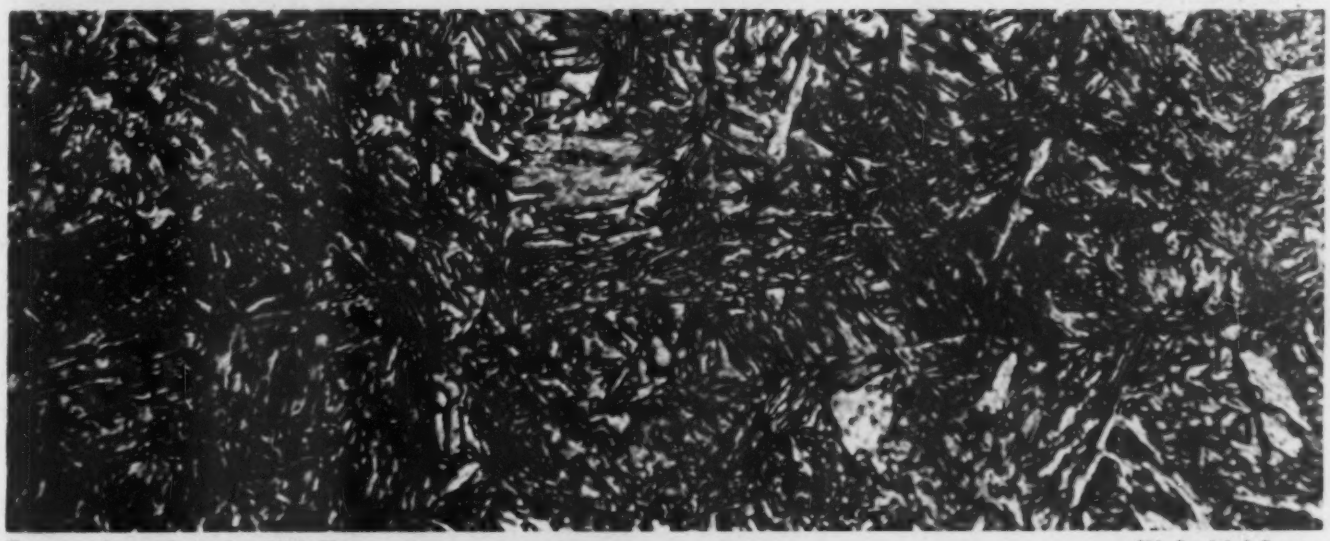
If the original surface is smooth, signs of possible overheating are easily seen. These signs occur where the metal is porous or cracked. The porosity or cracks disturb the induced currents so that they overheat the immediate area. Under normal treatment these faults

(*Continued on page 90*)



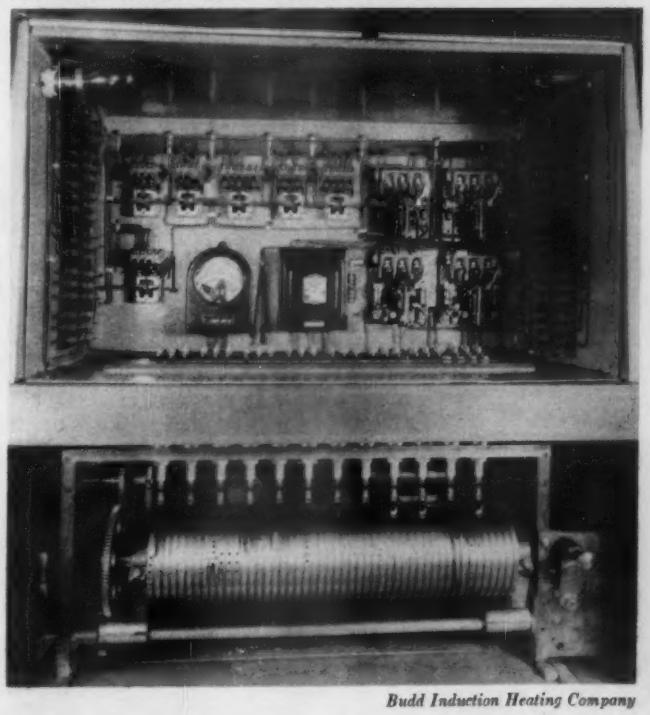
Induction heated steel. 1000-X

Ohio Crankshaft Company



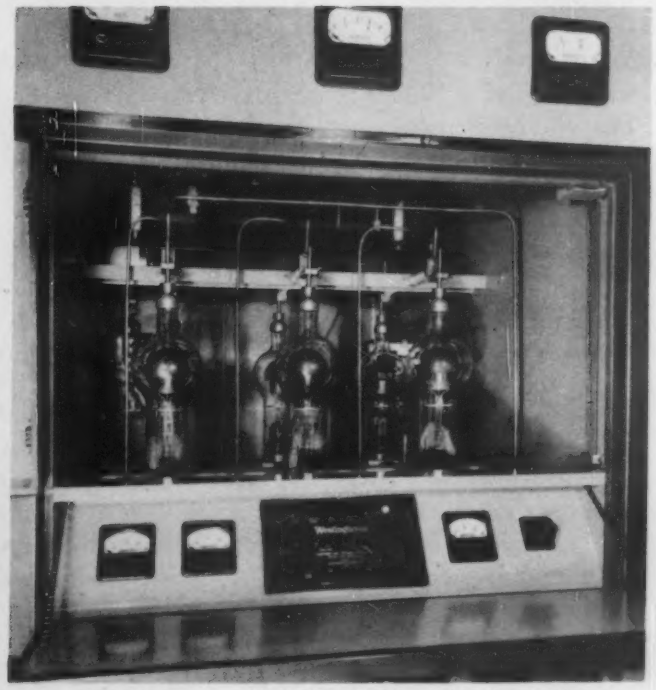
Furnace heated steel. 1000-X

Ohio Crankshaft Company



Budd Induction Heating Company

Relays and circuits for high frequency furnace help control time of tempering



Westinghouse Electric and Manufacturing Company

Thyratron tubes for controlling length of time of tempering

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FRANKLY SPEAKING...

RESEARCH FOR VICTORY

America's research program is now in full swing; literally thousands of scientists are intensively engaged on the multifarious technical problems of this highly mechanized war, and they are backed by ample funds. This represents a great stride forward since 1917 when much of the research in the opening months of that war had to be at the initiative and expense of the relatively few industrial research laboratories then in existence. That meant complete freedom in the choice of projects and in the planning and execution of programs, but difficulties frequently arose in obtaining sufficiently comprehensive knowledge of the details of the military problems and an adequate tryout of research results.

Conditions now, however, are very different. There is usually ample interest in research shown in Washington, shown by a willingness to back it with generous, almost prodigal appropriations. Mass attack is the order of the day. But even before the outbreak of war, practically every industrial company of any size had its own research laboratory, and as those companies turned to war work, so their laboratories began attacking, on their own initiative, the technical problems connected with their particular field of war production.

The splendid work of the industrial laboratories is being supplemented by large research groups, drawn mainly from the universities, who are pioneering in new fields which offer a prospect of radically new developments of war value. Here again the number of available workers is far larger than in 1917, for, in the past twenty-five years, the quantity and quality of the research work in colleges has increased enormously, with a corresponding increase in the number of trained men available to industry and private laboratories.

In all this work, one salient fact stands out as a reason for our success in research: America's industrial scientists, engineers, and production men have been trained to work in close coöperation, as an integrated team. Without such co-partnership, research is sterile and industry unprogressive; yet research, properly applied, provides the most important of all the raw materials with which industry works.

Research, engineering, and production — those three constitute the great team, achieving for us in peacetime continuous progress to ever higher standards of living, and in wartime continuous progress to victory.

But there must be full teamwork for maximum results, and full teamwork can be learned only by long and intensive coöperation. That is why our large industrial corporations have proved to be such towers of strength in this terrible emergency.

Large-scale research projects and large-scale engineering developments are exceedingly costly activities, and are quite beyond the financial capacity of a small company. Expenditures amounting to a million dollars or more are frequently necessary before a dollar of revenue can be expected. Such developments necessitate the creation and maintenance of large and well-equipped staffs of scientists and engineers, and such organizations become powerful agents for national defense.

(*Continued on page 88*)

Battle without headlines!

The men and women of Bell Telephone Laboratories are directing their energy these days to developing new and better communication equipment so vital in today's swift-moving global war.

Peacetime developments, pioneered by Bell Laboratories, are seeing action on every front. Many of their war-time achievements should prove stepping stones to progress in the coming days of victory and peace.

Service to the Nation—in war or peace, that's the one ideal of Bell System people.

WAR CALLS COME FIRST!

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AMERICAN TELEPHONE & TELEGRAPH CO. AND ASSOCIATED COMPANIES

BRIEFING THE NEWS . .

"SHOCK REFRIGERATION" SAFEGUARDS FLYING SUITS

A periodic cycle of cooling and heating is proving to be the best method of protecting expensive wool-and-fur flying suits from moths while they are stored between flights. The suits are used so frequently that chemical treatment is not satisfactory and may even damage the furs.

The normal storage temperature is 35° to 40° F. In the "shock" cycle, the storage room temperature is reduced to 15° F. for several days to kill any larva which may be feeding. Then, by cutting off the refrigeration and introducing heat (usually from strip heaters in the supply duct or coil chamber), the storage room temperature is quickly raised to 50° F., is again suddenly dropped to 15° F. for a day to kill off the surviving larva and any larva newly hatched. After one day at 15° F. the temperature is brought back to the 35° F. or 40° F. storage condition.

This entire procedure is repeated at regular intervals or, to prevent reinfestation, when any appreciable quantity of untreated articles of clothing is placed in the storage room. Relative humidity is high enough to prevent drying and cracking of the fur skin, but low enough to prevent mould or mildew. During the normal storage period with temperatures of 35° to 40° F., the relative humidity is about 50 per cent to 65 per cent.

Typical installations include a flying school using an open-type 7½ h.p. condensing unit with two-speed motor, and a horizontal type air handling unit with refrigeration coil.

At one typical aircraft factory three 25 h.p. condensing units, four air handling units with refrigeration coils are used.

BIRD GUN TESTS PLANE WINDSHIELDS

With plane speeds increasing, the risk of a large bird crashing through the windshield and endangering the life of the pilot and all others aboard demands attention. Under the guidance of the Civil Aeronautical Administration, a coöperative scientific study of just what happens to the windshield of a plane when struck at high speed by a heavy bird, is being made by airplane operators, builders and suppliers. The purpose is to learn how to construct windshields that have greater strength against such impact. The study is being made, strangely enough, in a laboratory used primarily for testing circuit breakers.

The test equipment consists of a high-velocity compressed-air gun. The gun, which has two interchangeable barrels, one five inches and the other ten inches in diameter — both 20 feet long, is connected to a reservoir of air under high pressure. Loaded with an electrocuted chicken or turkey the gun is fired at the test windshield. Velocities far above plane speeds now contemplated can be achieved.

Approximately a hundred tests have been made, using different speeds, angles of impact, sizes of birds, and types of windshields. Already engineers have learned how to increase the impact resistance tremendously. A standard transport plane windshield broke when struck by a four-pound bird at a speed of 75 m.p.h. The latest windshields tested withstood the impact of a four-pound bird at 300 m.p.h., and of a 15-pound bird at over 200 m.p.h.

A circuit breaker laboratory is remarkably well suited to such unusual tests. Large outdoor test cells, where circuit breakers are deliberately tested to destruction, provide an ideal shooting range. Oscillographs, cameras, and recording devices are at hand, and compressed air is available in quantity. The most important part of the gun is the trigger. Fortunately a high-speed air valve, recently developed for use with compressed-air circuit breakers, served the purpose without modification. This is another remarkable illustration of how the tools of peace are helping to hasten the day of victory.

STATIC ELECTRICITY INTERFERES WITH WAR EFFORT

Static electricity experiments have demonstrated that rubber tires impregnated with conductive materials drain static charges from trucks used in explosives plants, reducing the danger from sparks that might cause an explosion, according to Dr. Victor Wouk, twenty-three-year-old research engineer.

Big bombers can build up static charges powerful enough to give discomfiting jolts to ground crew men who touch the plane soon after it lands. This useless electricity may be the cause of a gasoline fire. On an extremely dry day, your automobile may build up an electrical pressure of 30,000 volts. These voltages rarely cause any damage in an automobile because the amount of electricity your car can hold is extremely limited.

To measure this tiny current Dr. Wouk fastened a wire to the body of a car and connected the wire to a microammeter, an extremely sensitive electrical instrument. Another wire attached to the microammeter was put through the rear window of the moving automobile and connected to a steel chain dragging in a grounded steel channel imbedded in an asphalt road. With this apparatus, he was able to make all the electricity in the car body flow back to the ground through the current measuring device.

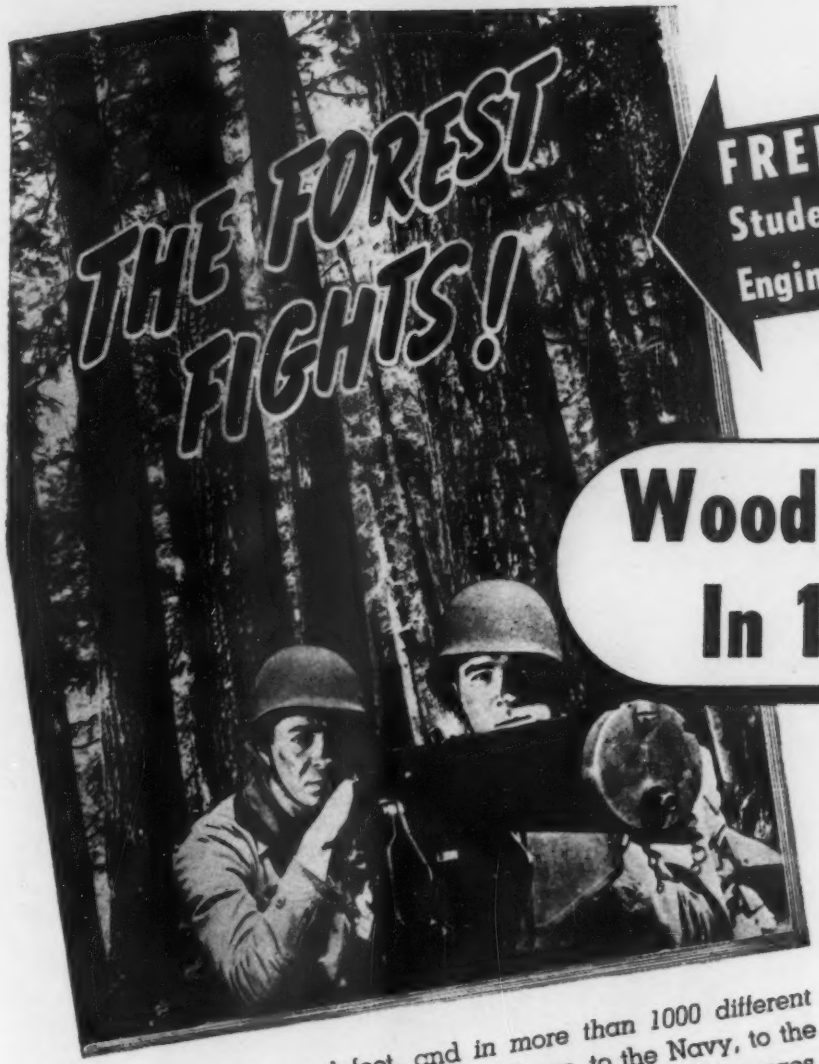
When a car is driven along a highway, the current stops flowing when the automobile becomes fully charged. When that point is reached all the electricity from the tires goes directly back into the roadway without passing through the body. The charge in a car drains away in a few seconds after the automobile stops; it rarely lasts longer than ten or fifteen seconds.

JAPAN DUE FOR EARTHQUAKES NEXT YEAR

According to the law of averages, Japan is due for another earthquake. In recent years Japan has suffered three major earthquakes, one in 1891, one in 1923, and one in 1927. Other disastrous quakes have occurred in 1896, 1920, 1933, and 1935. This does not include the hundreds of minor earthquakes which have only caused small damages.

These earthquakes have varied in intensity. In 1896 the island was practically split in two, and 40,000 lives were lost, while the one in 1923 resulted in 100,000 deaths. Formosa, the munitions storehouse of Japan, has a "belt" of quakes cutting across the middle of the island, and 4,000 were killed there in 1935.

There have been 19 severe earthquakes recorded in the time from 1903 to 1935, or an average of one every 18 months, the last one occurring in 1933. Of the 56 greatest surface earthquakes recorded in the past 40 years, five have occurred in Japan, or one every eight years. (*Continued on page 88*)



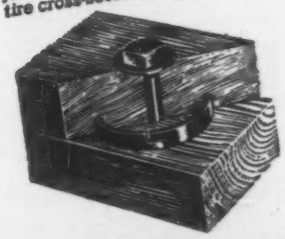
FREE to Students of Engineering

Wood Goes to War In 1000 Forms

By billions of board feet, and in more than 1000 different forms, lumber is streaming to the Army, to the Navy, to the Maritime Commission. This book of pictures — 48 pages, 200 illustrations — tells the amazing story of how Wood, on every front, is contributing to Allied victory.

You will see great war plants, shipyards, hangars, bridges — all built of timber . . . for today's structural engineers, using radically new methods, are working new wonders in timber construction. You will learn why and how these engineers use TECO RINGS — the modern connectors that so multiply the strength of timber joints and timber trusses that timber has been transformed, within a few years, from a simple carpentry material into a full-fledged, heavy engineering material.

The TECO Ring Connector spreads the load on a timber joint over practically the entire cross-section of the wood.



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FRANKLY SPEAKING . . .

(*Continued from page 84*)

Caught unprepared as our nation was, with its output of the implements of war only a pitiful fraction of what was needed, we had to revolutionize our productive facilities almost over night. Enormous problems had to be solved quickly and the solutions made immediately effective. The truly marvelous results obtained were possible only through intensive and efficient cooperation of scientists, engineers, and production men, coördinated by able management. It was chiefly in the large industrial corporations that such a combination was to be found in its fullest development, and naturally it was to such corporations that the Army and Navy turned to obtain the bitterly needed supplies.

Of course, it is no small sacrifice for many a scientist to turn from the alluring search for truth for truth's sake and for the good of mankind to the development of implements of destruction. This may mean a dislocation of deep-seated incentives, but sacrifice is the common lot of all in war, and the scientist has a special compensation in his knowledge that his war effort, beyond its primary and all-important purpose of contributing to victory over the enemy, will in all likelihood yield things of great value when peace returns.

Yet when American research, engineering and production have provided all the weapons needed for victory, thus placing it in the power of the United States to establish the basis of a lasting peace, there will still remain the question of whether they will use that power wisely, or whether, as in World War I, we shall win the war and lose the peace.

The problems will be many and difficult. Their solution will require all we possess of knowledge, of wisdom, of tolerance, of courage, and of unselfishness. The task will be gigantic, but the greater the task, the greater will be the opportunity for service, and the more glorious will be the reward of success. Yet success can be assured if we will follow the lead of a science dedicated to the advancement of peace.

Science *must* take the lead, and we *must* follow, for only by adhering to a carefully worked out plan of social and scientific reorganization that today's "younger generation," the business men and scientists of tomorrow, the men who will soon rule our common destiny, will be able to lead us into a better world.

The future belongs only to those who prepare for it.

General Electric Company

Dr. C. H. Bachman using electron microscope

BRIEFING THE NEWS . . .

(*Continued from page 86*)

NEW ELECTRON MICROSCOPE

Occupying a floor space of six square feet, having an overall height of 52 inches, and weighing under 600 pounds, a new and simplified electron microscope has been announced. With it the electron microscope has been brought within the range of all who need it.

The new microscope is different from older models in several ways. Electrostatic instead of electromagnetic fields are used to focus the electron beams on the object. These fields act in the same way as the lenses in the optical microscope, affecting the electron beams in the same way as the lens does light. Moreover, the method of viewing and mounting the specimen has been greatly simplified. There is no need for a water supply, and the means of inserting the specimen has been made much easier. Now the image may be photographed from or projected outside of the vacuum chamber.

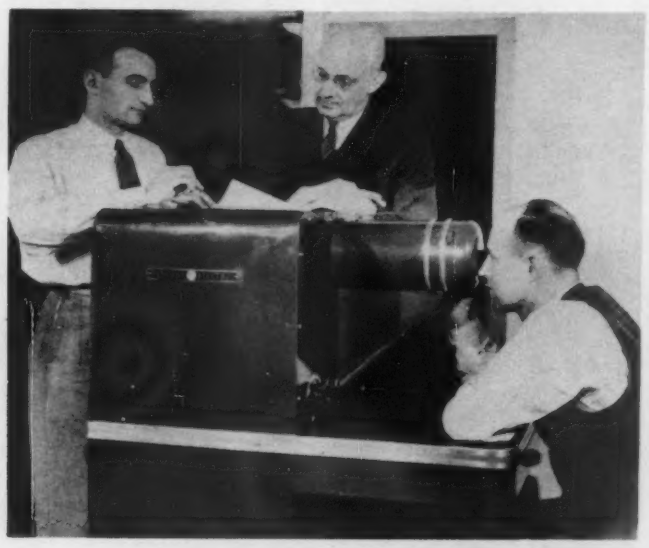
Physically, the new instrument has been designed for the convenience of the operator. Sitting in the master seat, he has all the controls, such as that of image intensity, voltage acceleration, and vacuum, specimen, and focus control, at his fingertips, besides being able to view the image without moving from his position.

Since the new microscope is mobile, requires no special facilities, and plugs into a 110-volt house current, it will be practicable for all conditions. Now under priorities, it is used by colleges and research organizations to further the war effort. In fact, there is hardly one field of science where its extra acute vision is not needed.

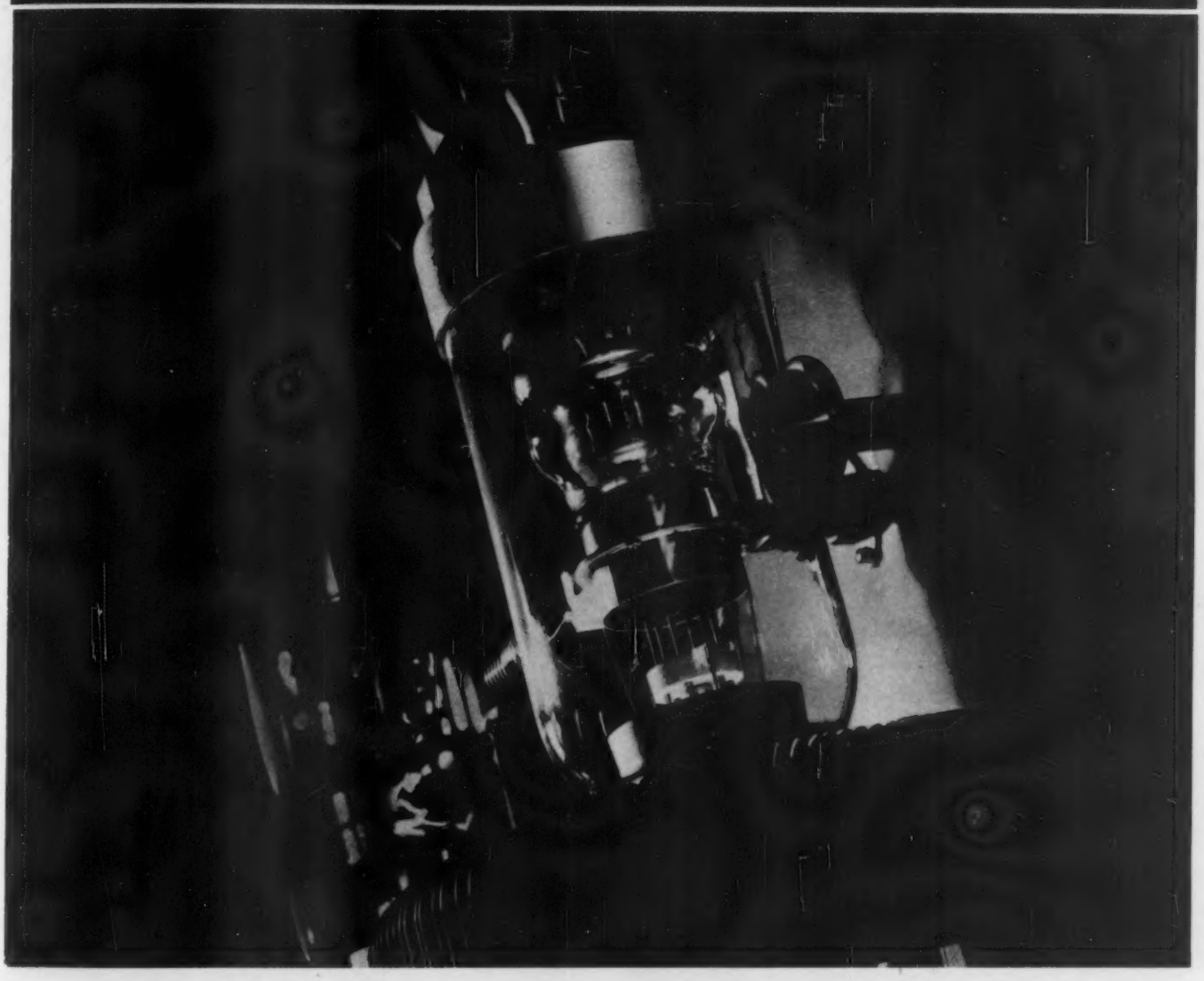
The ultra-short wavelength of the electron beam allows a resolving power far beyond that of the optical microscope, and permits one to study objects of almost molecular dimensions. The electron microscope has found use in biology, physics, metallurgy, physical chemistry, and other fields both for research and to check production methods. This new mode will make the electron microscope available to smalll laboratories where the size, cost, and often complexity of operation of earlier instruments are a handicap, and will broaden its usefulness as the portable, self-contained model can be taken to where it is needed, a fact of great importance in industrial applications.

General Electric Company

Dr. S. Ramo, W. C. White, and Dr. C. H. Bachman with electron microscope



This is Fred Allen's horse...



EVER wonder how Fred Allen manages to ride into millions of homes every week and emerge life-size and full-voiced from radio loud speakers?

The "horse" he rides is a big radio transmission tube like the one shown above. One reason it carries him smoothly and without interruption is that Corning research has perfected a glass for radio tubes that will stand heat and voltage of modern transmission.

Corning furnishes glass for the tubes in your own radio set, too. Just as it furnishes glass for many of your lamp bulbs; for the Pyrex cooking utensils in the kitchen back home. But to many, and particularly to the man who is making engineering his life work, Corning research is most interesting because of the things it has discovered that glass can do in competition with other materials, and do better. Glass springs, for instance, that apparently never tire out. Glass acid pumps that replace valuable metal alloys and give longer service in the bargain! Glass piping, and valves, nuts and bolts that resist chemical attack. Every day Corning is working on ways in which glass, still fairly plentiful, can be used to replace metals that are vital to war industry.

Glass is important today. And as more is discovered about this remarkable material, no one can predict the boundaries of its usefulness. For instance, glass precision gauges (ring, plug and others) are now being produced that are in many ways superior to ones made of steel.

As you get further into engineering, keep an eye on glass. The greatest things in glass are yet to come. Corning Glass Works, Corning, N. Y.

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means
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Precision Inks for Precise Performance

From the steamy dampness of the tropics to the icy dryness of the arctic, experienced draftsmen insist on Higgins American Drawing Inks. For they know they can depend on the *precise performance* of Higgins Inks under all working conditions.

For more than 63 years Higgins American Drawing Inks have been winning world-wide respect for their superior qualities — for free flow and sharp surety of line. Draftsmen know that with reasonable care Higgins American Drawing Inks retain their qualities of *precision performance* unless actually exposed to freezing.

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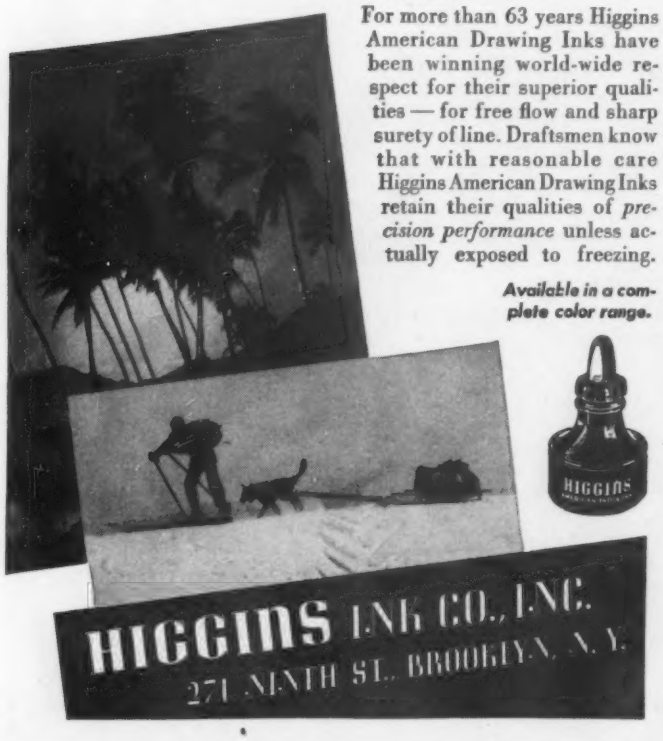
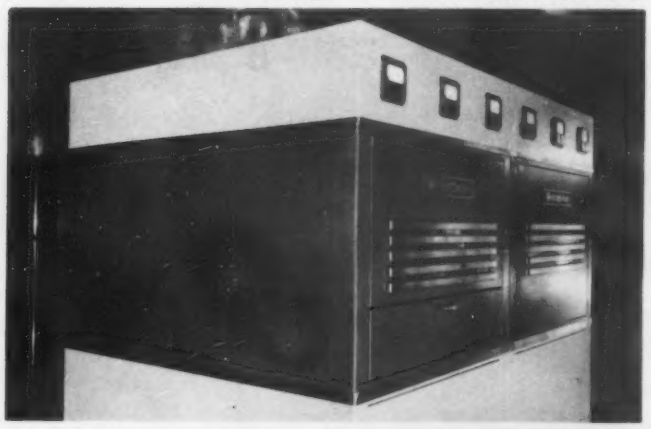
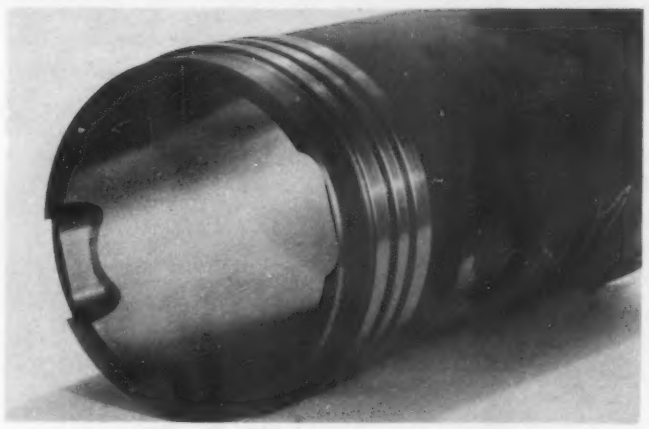


High frequency induction furnace

Westinghouse Electric and Manufacturing Company





HIGH FREQUENCIES

(*Continued from page 82*)

would be found only by microscopic or magnetic inspection.

To the metallurgist, his dream has come true with the use of induction heating. External surfaces can be treated to any degree of hardness and depth, leaving the rest of the metal with its original properties. The variety of parts that this process can be used for are numerous, including all sizes and shapes. The proper hardening of the surface gives the main body longer life, since it remains relatively soft and will not break easily.

There are different ways in which the process of surface hardening is done, the way depending on the size and shape of the object to be hardened. Crankshafts which can be manually handled are treated in vertical units in which three or four are hardened automatically in one controlled operation. On the other hand, if it is a large diesel crankshaft, it will be treated in a long tunnel-like unit in which each bearing is treated in a separate induction coil or inductor block. Since all the blocks can be controlled by one large control unit each bearing will have a duplicate hardening as far as it is possible considering the differences in the bearing steel.

In supplement to external surface hardening is internal surface hardening, which is the most recent advance in induction heating. For the same reasons as external surface hardening, it is equally important. Although the fundamental process is the same as external hardening, the scope of the process is limited by physical conditions. These two conditions are first, diameters less than one inch make it extremely difficult to design the necessary apparatus, and second, diameters greater than fifteen inches require a tremendous amount of heat, and treating becomes impractical because of the amount of power required to produce this heat.

Units creating the high-frequency waves are vacuum tube oscillators, essentially the same as the transmitter of a radio station. Alternating current is first converted to a direct current, which is fed to the oscillating tubes, where it is "chopped up" into a high-frequency alternating current, so called because it changes its direction 400,000 times a second.

Induction heating is accompanied by many economical advantages. Equipment can be designed to fit into any assembly line, and since it takes but a few seconds to harden the part, production rates can be maintained. The units can also be designed in order that a rapid changeover can be made for irregular sizes and shapes, and since the controls can be assembled in one main control box, all parts can be treated similarly, assuring almost identical pieces. The amount of heat given off from an induction heating unit is small compared with furnace heating, since the time interval during which the heat is actually produced is much less than that of a continually burning furnace. Also, immediate quenching reduces the heat of the metal so that when it is removed from the unit, it can be readily handled.

Thus through the progress of science an important job is being speeded up, and at the same time the quality of the job done has been greatly improved.

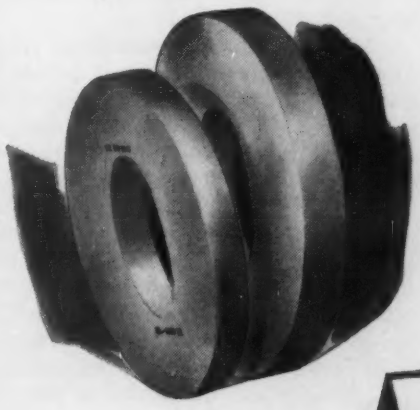
Finished high frequency heat-treated piece showing inside free from scale cylinder lines

Budd Induction Heating Company

What's the hottest spot in a Dog Fight ?

A pilot may keep cool in a "dog fight"—but not his engine! And to function smoothly at high engine temperatures all moving parts must be ground and finished with split hair precision. And that's where Carborundum comes in. For instance, the valve stems are ground to the required accuracy by a centerless grinding process which Carborundum helped develop.

The centerless grinder grinds the valve stems to an accuracy of five ten-thousandths of an inch. Does it, too, in half the time other finishing methods would require. Carborundum has led in the development of centerless grinding wheels to speed the output of valves, pistons, shafts and other such parts that go into a plane.



Industry at war is finding new uses for grinding wheels and other abrasive products...Weapons for Production...every day. When you get in the field and encounter a production problem which abrasives might solve, write The Carborundum Company, Niagara Falls, N. Y.

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FOR Victory AND AFTER

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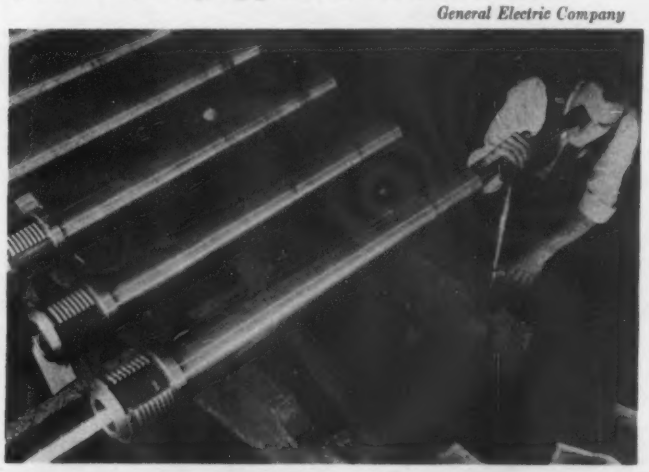
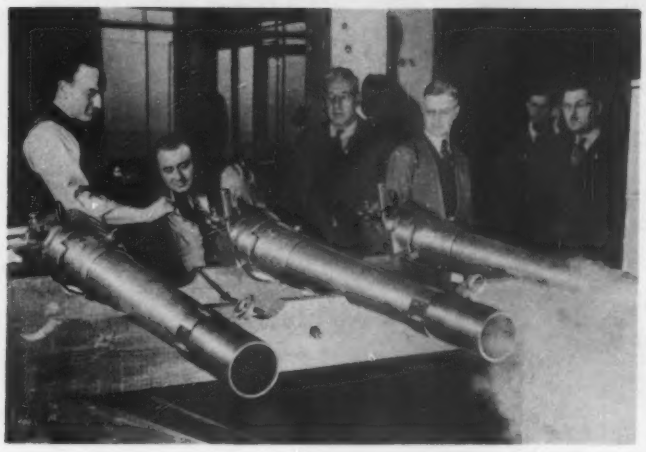
Our research to maintain and improve the quality of Simplex insulated wires and cables, under restrictions designed to save critical materials, is getting results that mean better insulated conductors for commercial use after the war.

Simplex Wire & Cable Co.
79 Sidney Street, Cambridge, Mass.

A borescope light is used for visual examination of the bore and rifling groove in a 75-mm. howitzer
General Electric Company





SUPPLIERS FOR VICTORY

(*Continued from page 81*)

manuals and will perform authorized duties in connection with assigned field establishments.

Prior to the year 1942, graduates from the M. I. T. Ordnance R. O. T. C. Unit were ordered to active duty in any one of the above named divisions of the Ordnance Department and we find many of them scattered throughout the Service. Today the trend is mainly directed towards the Field Service Division for reason that the other divisions have reached approximately their full expansion, while the need of officers today is for our rapidly expanding Field Service forces.

To some the Field Service appears to be an obscure and disinteresting assignment, but let us take a look at what it has to offer. To start with, we have many types of maintenance companies, in fact we have regiments devoted to the maintenance work. This work will vary from that which has to be done in a stable type of large shop where heavy repair and alteration tasks must be performed on every conceivable type of Ordnance equipment to the simple maintenance party consisting of possibly two men and a light pickup vehicle having the task to perform a service close to the front line.

Our maintenance companies may form a part of the Ordnance Battalion with the Corps or may be assigned alone to a Division of Infantry. Again we have units serving with the Armored Forces as well as with the Air Forces. A young man may choose an assignment anywhere his initial training has qualified him for, provided there is a vacancy.

When we speak of a maintenance company, we hide perhaps the fact that it is a highly mobile Ordnance company having such machinery as drill presses, shapers, lathes, grinders, motor generator sets, arbor presses, gas and electric welding equipment and just about any piece of equipment that can be mounted in light vehicles which will be required to maintain artillery or small arms weapons, self-propelled mounts, motor combat or transport vehicles and even delicate optical instruments in the field. Look into the matter more deeply and you will find that the young lieutenant will have under his immediate supervision highly trained and skilled mechanics and specialists of no mean ability. These men are his to further train and direct under conditions which will cause him to use every bit of his engineering training and self-ability. There also comes a supply task, wherein he must keep his stocks of spare parts and materials at a level which will permit him to accomplish each and every mission assigned to him.

The ammunition battalions present a slightly different problem in that it is principally one of storage and supply, coupled with a bit of technical training, and training and management of large numbers of men. Here a business engineer or a chemical engineer will find an opportunity to use that training which he has received at school. The importance of the ammunition supply must not be overlooked because it represents the highest percentage of tonnage required to maintain fighting troops in the field and its supply must be certain or our armed forces will surely fail.

It would be wrong to close this article without making some comment on the present M. I. T. R. O. T. C.

(*Continued on page 95*)

As a final test, primers in empty shell cases are fired just as if the gun were being used in actual combat
General Electric Company

This "Carrot" means healthy metals

YOU CAN SEE why metalworkers call this lump of calcium metal a "carrot." This is the way it looks when it comes from an electrolytic cell in which it is made.

Calcium is a soft, silvery-looking metal. Although it is abundantly present in such common materials as chalk and limestone, its recovery as a pure metal is extremely difficult. Yet it is vitally essential to this country.

In the making of stainless or high-alloy steels, calcium drives out impurities, giving cleaner, better steel for casting or rolling. In magnesium casting, small amounts of calcium improve the finish of the surface and minimize scaling. Calcium is an essential in the making of many metals.

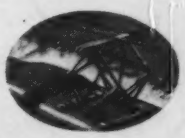
This hitherto rare metal has been made in this country only during the past few years. Before Europe exploded, the United States was dependent upon France as a source of supply.

But back as far as 1935, thinking that this country should have a domestic source, ELECTRO METALLURGICAL COMPANY, a unit of UCC, started a major research program. After four years of work . . . as French supplies dwindled . . . a plant was put into operation for the manufacture of the gray metal. Today, ELECTRO METALLURGICAL COMPANY produces many times as much calcium metal as this country ever imported . . . and production is increasing.

IN THE AIR SOONER! Vital aircraft parts flow from production lines quicker because the use of calcium metal results in better metal.

BETTER HEALTH! Pure calcium metal is used as a drying and purifying agent in the manufacture of certain new disease-fighting drugs.

CHEMICAL HELPER! Calcium is necessary in making a number of rare metals—many of which heretofore were unavailable commercially—and all of which are vital.



METAL-SAVER! In the melting of copper scrap for use in certain types of electrical equipment, calcium is used as a purifier and a restorer of electrical conductivity.

BUY UNITED STATES WAR BONDS AND STAMPS

UNION CARBIDE AND CARBON CORPORATION

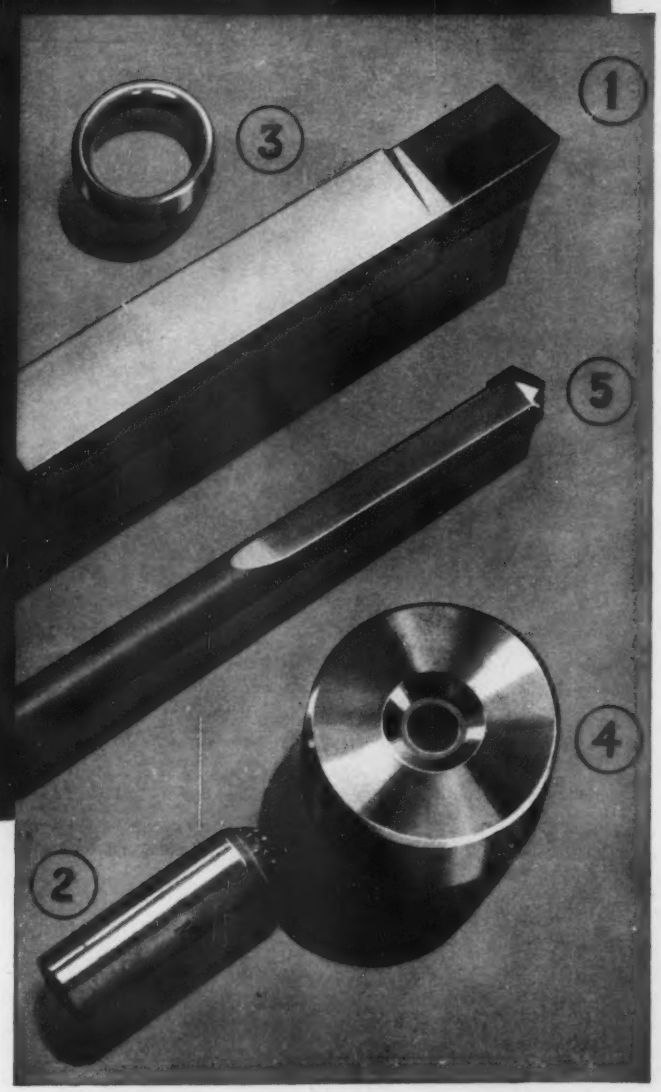
UCC

30 East 42nd Street — New York, N. Y.

Principal Products

ALLOYS AND METALS
ELECTRODES, CARBONS AND BATTERIES
INDUSTRIAL GASES AND CARBIDE
CHEMICALS — PLASTICS

These are the 5 WAYS in which industry is stepping up WAR PRODUCTION With Carbides



1. Cutting Metals Faster! . . . Carbide tools commonly double the volume of metal removed per hour. Cut wide range of material, from "tough" armor plate to "soft" plastics. Continuous or interrupted cuts. Adaptable to most old machines, as well as new.

2. Dressing Grinding Wheels Easier! . . . Diamond-Impregnated Carboloy dressers make diamonds do a full day's work every day! No time out for remounting. No lost diamonds. No "pampering" temperamental stones. Diamonds held permanently in place. Used in 3 sizes for wheels up to 42" diameter.

3. Keeping Machines Running! . . . Stopping "shut-downs" caused by excessive wear on such parts as rollers, cams, guides, gages, valves, etc., used on plant equipment. Just a small insert of carbide at the point of wear often increases life of parts up to 100 times longer. (Carboloy guide for wire stranding machine illustrated above is typical wear-resistant use.)

4. Drawing Metals! . . . Drawing, sizing, extruding metals through carbide dies provides better finish, greater accuracy, larger output, more continuous operation. Used for wire, bar, tubing, sheet metal. Widely employed for drawing cartridge cases from .30 cal. through 105 mm.

5. Installing Equipment Faster! . . . For installing new equipment, wiring and piping, or relocating present machines, carbide masonry drills drill holes 75% faster in concrete, brick, tile, porcelain, plaster.

CARBOLOY COMPANY, INC., 11179 E. 8 MILE ROAD, DETROIT, MICH.

(Sole makers of the Carboloy brand of cemented carbides)

Birmingham • Chicago • Cleveland • Los Angeles • Newark • Philidelphia • Pittsburgh • Seattle

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CARBOLOY CEMENTED CARBIDES

TRADEMARK

TOOLS • DIES • DRESSERS • MASONRY DRILLS • WEAR RESISTANT PARTS

SUPPLIERS FOR VICTORY

(*Continued from page 92*)

Ordnance Unit. We find that it has doubled its peacetime strength and possibly could increase slightly more without loss of efficiency.

The cadets have shown a quickened interest in Ordnance matters and have sought training other than that required by the War Department schedules. This past year, through the coöperation of nearby combat arms and Ordnance establishments, the unit made numerous trips to view either Ordnance service work or the combat troops at their tasks.

The visits to the combat services consisted of an inspection of a 105 mm. howitzer battery and a 155 mm. howitzer battery. These troops conducted a special drill in the service of the piece for the cadets. The cannoneers demonstrated the stripping of the pieces for cleaning and instructed the cadets in each phase of the work. Later the unit was fortunate in attending the range practice of a 105 mm. battery, firing on high speed moving tank targets. This opened the cadet's eyes to the possibilities of the American artilleryman armed with that weapon. Hits were frequent and the cadets left the range with a new understanding of the capabilities of the American soldier and a clearer idea of the Ordnance work which they would assume upon graduation. It brought home to the boys the fact that the Ordnance service was one service which actually gave service and did not resort to the old game of "passing the buck." The combat troops heartened the boys greatly by openly expressing their high appreciation of the services always rendered them by the Ordnance Department.

(*Continued on page 96*)

In getting the howitzer ready for its sighting mechanism, it is supported by a fixture which simulates a gun carriage *General Electric Company*

Putting STEAM into the WAR EFFORT

Every ship, plane, tank and tractor, like every gun, bomb and shell, is a product of power. Power, ever more power, is needed to win in global warfare . . . and steam power carries the bulk of the load.

Because this is so, and because Babcock & Wilcox is America's largest producer of steam generating equipment, B&W employment has increased at a rate far in excess of that shown by industry's average. All this effort today is devoted to helping utilities, industrial power plants and ships produce the power to win this war. When victory and peace have been won, B&W facilities will be ready to help you, the engineers of tomorrow, meet your post-war power responsibilities.

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"The Design Of Water-Tube Boiler Units." Not a manual of design, this interesting book explains what types of boilers are used for the most common types of service and why. Your copy will be sent on request.

G-243

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Howitzer components are carefully fitted and hand finished under the eyes of Army inspectors *General Electric Company*

Cutting the threads which will help to seal the howitzer after loading *General Electric Company*

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The Lufkin Metallic is the best of woven tapes. Coated line with metallic warp resists wear, moisture, stretching and fraying. Large, clear markings make it easy to read. When equipped with folding hook ring, measurements can be easily taken unassisted.
See it at your dealer and write for free catalog.
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ENGINEERS AND TECHNICIANS

INTERESTING WORK on post-war research and war projects in one of the world's largest air conditioning and refrigeration research laboratories with excellent opportunity for obtaining industrial experience and post-war employment, if desired, for

(1) LABORATORY SUPERVISOR to organize testing procedure and direct the work of laboratory technicians.

(2) ENGINEERS in design and research work on refrigeration and air conditioning equipment and in development on essential war contracts.

(3) LABORATORY TECHNICIANS to direct the complete erection of test set-ups and direct and supervise the actual test runs.

(4) INSTRUMENT TECHNICIANS to do instrument calibration and to be in charge of instrument storage, repairs, etc.

Please write: Mr. T. M. COX
Personnel Department, Carrier Corporation
Syracuse, New York

SUPPLIERS FOR VICTORY

(*Continued from page 95*)

In one case a few of the cadets were able to observe the proof testing of a 16-inch coastal defense rifle. Here they saw, felt and heard the biggest weapon fired, perhaps, that they would be called upon to service. This became possible through the spirit of coöperativeness of the Coast Artillery.

In visiting the Ordnance establishments, the cadets were fortunate in being able to make two separate inspections of a Medium Maintenance Company. They were permitted to ask any questions of the officers or the soldiers that they desired. In another instance a visit was made to a Post Ordnance shop where the personnel was servicing several types of new anti-aircraft artillery weapons. They were given brief descriptive talks by the specialists.

Again the cadets were given an opportunity to ride in and inspect a number of the very newest types of self-propelled mounts. It was a regular field day which was closed with a final inspection of an ammunition storage area.

A highlighted trip was to a small arms manufacturing plant where many manufacturing operations were revealed. Here the cadets could better see complicated points of manufacture which had puzzled them during their studies. A prominent inventor gave an excellent demonstration of automatic rifle marksmanship and each cadet had the opportunity to fire several types of weapons.

On another occasion the cadets visited a cartridge case manufacturing plant which was of truly modern design. Added interest was aroused when they learned that their guide, a former M. I. T. Ordnance student, had had much to do relative to the design of the tools used.

A limited amount of time has been devoted to rifle and pistol marksmanship range practice this past year and while conditions were not entirely ideal the cadets were able to fire the pistol, Thompson and Reising submachine guns and the small bore rifles. This phase of the training will be increased as it is highly important. The young officer must be able to instruct troops in marksmanship and should be given an opportunity to perfect himself.

In addition to routine classroom work, every effort is made to give the cadets an opportunity to take charge of some part of the actual Ordnance instruction by giving demonstrative lectures varying from fifteen minutes to a full hour. Here the cadet is able to begin his work as an instructor without undergoing a period of uneasiness which usually accompanies this task, as he is definitely among friends although his audience may be critical.

In all of the work conducted by the Ordnance unit it has received full coöperation from the various departments at M. I. T. Many of the trips could not have been made without this coöperation. It has been interesting to note the keen interest shown by former M. I. T. men, now in the Ordnance Department, in the coördination of the inspection trips and the arrangement of excellent instructional programs from which the cadets derived great benefit. The spirit which has prevailed throughout has given the cadets a feeling of confidence. It will be this feeling of confidence which will enable them to begin their active duty assignments without the usual fear of meeting the unknown.

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GEAR TEETH HARDENED IN 8 SECONDS

IN only a few seconds the oxyacetylene flame adds greatly to the service life of this internal gear. Teeth and other surfaces subject to wear are rapidly hardened by the modern oxyacetylene flame treating process. The depth of hardening is easily and accurately controlled, without affecting the inherent toughness of the core metal.

Airco Flame Hardening gives all the advantages of other surface hardening methods plus speed and ease of application. Simple arrangements using one or more torches permit flame hardening of a large variety of metal parts on a production basis.

Many other applications of the oxyacetylene flame are finding ever widening application in speeding and improving production of ships, tanks, guns, rolling stock and planes. This versatile tool slices through steel with remarkable speed—welds metal into strong, light units—sweeps surface rust from metal structures to extend the life of paint jobs—gouges steel and iron quickly and accurately.

To better acquaint you with the many things that this modern production tool does better we have published "Airco in the News", a pictorial review in book form. Write for a copy.

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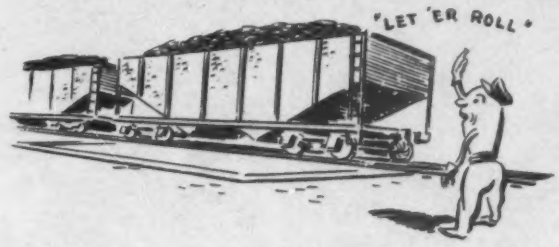
G-E Campus News



LET HER ROLL!

AT A PLANT of the Hanna Coal Company in Ohio, loaded coal cars are emptied by being rolled onto a rotary dump, fastened to the rails by a mechanical device, and then rolled upside down over a chute.

Now the dump is not supposed to revolve again until the empty car has been righted and sent on its way. But once in a while, when a car took a particularly long time to move off, the dump would revolve the next full car and derail the empty one.

The difficulty was remedied when a G-E photo-electric relay and light source were installed on opposite sides of the track at the "empty" end of the dump. Now the dump can't revolve so long as the light beam between the light source and the phototube in the relay is blacked out by the body of the empty car.

NOTHING TO IT

HERE'S how the G-E supercharger works—à la Hollywood.

In Warner Brothers' "Desperate Journey," a Nazi officer asks a captive American flyer, "How do you manage to supercharge the engines at the extreme cold of these high altitudes?"

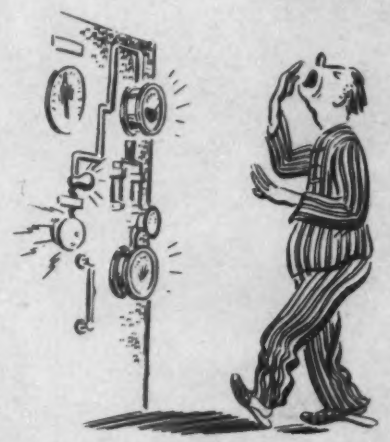
Johnny, the prisoner (played by Ronald Reagan) is crafty. He stalls a bit and then, assured that no one can overhear, he whispers, "It's done with a thermo-trockle."

"A what?" The awed Nazi leans closer.

"A thermotrockle amfilated through a daligoniter," explains Johnny, beginning to sketch with his left hand.

"You see, the dornadyne has a frenicoupling and the amacmeter prenulates the kinutaspel hepulace—here—and the—."

All of which thickens the plot, confuses the Nazi, and gives Johnny an opportunity to slug his guard and escape—without revealing a single military secret.



TESTING

BACK when Herbert Hoover was in the White House, four specimen rods of an alloy steel used in steam turbines were imprisoned in a thermostatically controlled electric furnace at one of the G-E laboratories.

The purpose was to study the effect on the metal of prolonged high temperature and stress, in order to improve the design of the turbines.

Usually these "creep" tests are run for only 1000 to 3000 hours, but the engineers never took these four specimens out of the furnace until the other day—thus obtaining what they believe to be the first data based on a 100,000-hour test.

Throughout the 100,000 hours an ingenious alarm system guarded the specimens. In the event of trouble, a red light would flash and a bell would ring, summoning a watchman who could get one of the engineers out of bed to remedy the situation.

GENERAL ELECTRIC

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TECHNOLOGY